Florida Department of Transportation

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605 Suwannee Street
Tallahassee, FL 32399-0450

KEVIN J. THIBAULT
SECRETARY

July 8, 2019

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section: **933**
Proposed Specification: **9330102 Prestressing Stand and Bar.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Scott Arnold in the Structures Design Office to clarify the mechanical and dimensional properties of stainless steel strands.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to stefanie.maxwell@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4140.

Sincerely,

Signature on file

Stefanie D. Maxwell, P.E.
Manager, Program Management Office

SM/rf
Attachment
cc: Florida Transportation Builders' Assoc.
State Construction Engineer

PRESTRESSING STRAND AND BAR
(REV 5-13-19)

SUBARTICLE 933-1.2 is deleted and the following substituted:

933-1.2 Stainless- Steel Strands for Prestressing: The stainless- steel strands for prestressing concrete members shall be a high strength stainless- steel (HSSS) conforming to the chemical requirements of ASTM A276-, UNS S31803 or S32205 (Type 2205). ~~and the mechanical and dimensional requirements of ASTM A416, except the minimum ultimate tensile strength shall be 240 ksi~~The mechanical and dimensional requirements shall follow the requirements of ASTM A416 except as modified by this Section. The breaking strength shall conform to the requirements of Table 1-1. The minimum yield strength shall be 85% of the breaking strength listed in Table 1-1. The total elongation under load shall not be less than 1.4%. Stainless-steel strand shall conform to a size tolerance of +0.026 in., -0.006 in. from the nominal diameter measured across the crowns of the wires.

Table 1-1
Breaking Strength Requirements of Stainless-Steel Strand

Nominal Diameter (in)	Nominal Cross Sectional Area (in^2)	Minimum Breaking Strength (kips)	Nominal Ultimate Tensile Stress (ksi)
0.52	0.167	40.1	240
0.62	0.231	55.4	240

SUBARTICLE 933-1.3 is deleted and the following substituted:

933-1.3 Carbon- Fiber- Reinforced Polymer (CFRP) Strands for Prestressing: Obtain CFRP prestressing strands from producers currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105. CFRP strand shall meet the requirements of this Section.

Table 1-2~~1~~
Typical Sizes and Loads of CFRP Prestressing Strands and Bars

Type	Nominal Diameter (in)	Nominal Cross Sectional Area (in^2)	Nominal Ultimate Load (P_u) (kips)	Nominal Ultimate Tensile Stress (ksi)
Single Strand - 5.0mm Ø	0.20	0.030	9	300
7-strand - 7.5mm Ø	0.30	0.050	17	340
7-strand - 10.5mm Ø	0.41	0.090	32	356
Single Strand - 9.5mm Ø	0.38	0.110	35	318
7-strand - 12.5mm Ø	0.49	0.118	41	347
Single Strand - 12.7mm Ø	0.50	0.196	59	301
7-strand - 15.2mm Ø	0.60	0.179	61	341

19-strand - 20.5mm Ø	0.81	0.320	71	222
7-strand - 17.2mm Ø	0.68	0.234	79	338
19-strand - 25.5mm Ø	1.00	0.472	105	222
19-strand - 28.5mm Ø	1.12	0.621	134	216
37-strand - 35.5mm Ø	1.40	0.916	189	206
37-strand - 40.0mm Ø	1.57	1.240	270	218

SUBARTICLE 933-5.2.1 is deleted and the following substituted:

933-5.2.1 Steel Strands: Acceptance of steel prestressing strands shall be based on samples taken by the Department and the producer's certified mill analysis certifying that the test results meet the specification limits of ASTM, ~~or~~ AASHTO, or FDOT as specifically designated. Prior to use, submit to the Engineer the producer's certified mill analysis for each heat or production LOT per shipment of strand.

Certifications for steel prestressing strand shall contain, for each heat number or production LOT, all test results required by ASTM A416 and the modulus of elasticity expressed in psi or the stress-strain curve with units identified.

The Engineer will select samples and certified mill analysis representing each shipment at a frequency of one sample per producer, per size of strand, per shipment.

SUBARTICLE 933-5.2.2 is deleted and the following substituted:

933-5.2.2 Carbon-Fiber-Reinforced Polymer (CFRP) Strands: Producers shall submit to the State Materials Office (SMO), a test report of the physical and mechanical property requirements in Table 5-1. Qualification testing shall be conducted by an independent laboratory approved by the Department for performing the FRP test methods. Three production LOTS shall be randomly sampled at the production facility by a designee of the SMO. The minimum number of specimens per production LOT shall be as indicated in Table 5-1. The coefficient of variation (COV) for each test result shall be less than 6%. Outliers shall be subject to further investigation in accordance with ASTM E178. If the COV exceeds 6%, the number of test specimens per production LOT may be doubled a maximum of two times, to meet the COV requirement. Otherwise, the results shall be rejected. A production LOT is defined as a LOT of CFRP strand produced from start to finish with the same constituent materials used in the same proportions without changing any production parameter, such as cure temperature or line speed.

Table 5-1
Physical and Mechanical Property Requirements for CFRP Prestressing Strands

Property	Test Method	Requirement	Specimens per LOT
Fiber Mass Fraction	ASTM D2584 or ASTM D3171	≥70%	10
Short-Term Moisture	ASTM D570, Procedure 7.1; 24 hours immersion at 122°F	≤0. 25%	10

Table 5-1 Physical and Mechanical Property Requirements for CFRP Prestressing Strands			
Property	Test Method	Requirement	Specimens per LOT
Absorption			
Long-Term Moisture Absorption	ASTM D570, Procedure 7.4; immersion to full saturation at 122°F	≤1.0%	10
Glass Transition Temperature (T_g)	ASTM D7028 (DMA) or ASTM E1356 (DSC; T_m)/ASTM D3418 (DSC; T_{mg})	≥230°F ≥212°F	3
Total Enthalpy of Polymerization (Resin)	ASTM E2160	Identify the resin system used for each bar size and report the average value of three replicates for each system	-
Degree of Cure	ASTM E2160	≥95% of Total polymerization enthalpy	3
Measured Cross Sectional Area	ASTM D7205	Within -5% to +10% of nominal values listed in Table 1-2~~1~~	10
Ultimate Tensile Strength (UTS)		≥ Value listed in Table 1-2~~1~~	
Tensile Modulus		≥18,000 ksi	
Alkali Resistance with Load	ASTM D7705, 3 months test duration at 140 ± 5°F. Apply sustained tensile stress to induce 3000 micro-strain, followed by tensile test per ASTM D7205	Tensile strength retention ≥70% of UTS	5
Creep Rupture Strength	ASTM D7337, 3 months test duration at laboratory conditions. Apply sustained tensile load equivalent to 75% UTS, followed by tensile test per ASTM D7205	Equivalent sustained load ≥75% UTS AND Tensile strength retention ≥90% UTS	3

SUBARTICLE 933-5.2.2.2 is deleted and the following substituted:

933-5.2.2.2 Sampling: The Engineer will select a minimum total of 42 feet from each shipment, representing a random production LOT, per size of CFRP strand for

testing in accordance with Table 5-2. The minimum discrete sample length shall be 7 feet. Testing shall be conducted, at the Contractor's expense, by a Department approved independent laboratory. Each test shall be replicated a minimum of three times per sample. Submit the test results to the Engineer for review and approval prior to installation.

Table 5-2
Testing requirements for Project Material Acceptance of CFRP Prestressing Strand

Property	Test Method	Requirement
Fiber Mass Fraction	ASTM D2584 or ASTM D3171	≥70%
Short-Term Moisture Absorption	ASTM D570, Procedure 7.1; 24 hours immersion at 122°F	≤0.25%
Glass Transition Temperature	ASTM D7028 (DMA) or ASTM E1356 (DSC; T_m)/ASTM D3418 (DSC; T_{mg})	≥230°F ≥212°F
Degree of Cure	ASTM E2160	≥95% of Total polymerization enthalpy
Actual Cross Sectional Area	ASTM D7205	Within -5% to +10% of nominal values listed in Table 1-2~~1~~
Ultimate Tensile Strength		≥ Value listed in Table 1-2~~1~~
Tensile Modulus		≥18,000 ksi

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Table 5-1
Physical and Mechanical Property Requirements for CFRP Prestressing Strands

Property	Test Method	Requirement	Specimens per LOT
Fiber Mass Fraction	ASTM D2584 or ASTM D3171	≥70%	10
Short-Term Moisture Absorption	ASTM D570, Procedure 7.1; 24 hours immersion at 122°F	≤0. 25%	10

Table 5-1 Physical and Mechanical Property Requirements for CFRP Prestressing Strands			
Property	Test Method	Requirement	Specimens per LOT
Long-Term Moisture Absorption	ASTM D570, Procedure 7.4; immersion to full saturation at 122°F	≤1.0%	10
Glass Transition Temperature (T_g)	ASTM D7028 (DMA) or ASTM E1356 (DSC; T_m)/ASTM D3418 (DSC; T_{mg})	≥230°F ≥212°F	3
Total Enthalpy of Polymerization (Resin)	ASTM E2160	Identify the resin system used for each bar size and report the average value of three replicates for each system	-
Degree of Cure	ASTM E2160	≥95% of Total polymerization enthalpy	3
Measured Cross Sectional Area	ASTM D7205	Within -5% to +10% of nominal values listed in Table 1-2	10
Ultimate Tensile Strength (UTS)		≥ Value listed in Table 1-2	
Tensile Modulus		≥18,000 ksi	
Alkali Resistance with Load	ASTM D7705, 3 months test duration at 140 ± 5°F. Apply sustained tensile stress to induce 3000 micro-strain, followed by tensile test per ASTM D7205	Tensile strength retention ≥70% of UTS	5
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